REMARKS

The Office Action of May 5, 1998 was received and carefully reviewed. Reconsideration and withdrawal of the currently pending rejections are requested for the reasons advanced in detail below.

Claims 1-4, 6-9, 11-14, 16-19, 21-24 and 39-72 were pending prior to the instant amendment. By this amendment, these claims are canceled, and new claims 73-86 are added to recite additional features of the present invention to which Applicants are entitled. Consequently, claims 73-86 are pending in the instant application.

It is respectfully submitted and made of record that claims 1-4, 6-9, 11-14, 16-19, 21-24, and 39-72 are canceled for the purpose of expediting the acquisition of patent protection. These cancellations do not constitute an admission as to the patentability of these canceled claims or to the validity of the Examiner's rejections of these canceled claims. The Applicant continues to believe that these canceled claims are patentable and therefore, reserves the right to continue the prosecution of these canceled claims in a divisional patent application.

In addition, Applicants note that the Examiner has not yet evidenced consideration of the reference cited in the *Information Disclosure Statement* (IDS) filed February 23, 1998. As a result, it is respectfully requested that the Examiner include a copy of the initialed Form PTO-1449, that was included with the IDS, with the next communication evidencing consideration of the reference.

The claimed invention is related to a thin film transistor having at least a channel forming region with no grain boundary. It is important when forming a region in a semiconductor film with no grain boundary to suppress impurities such as carbon, nitrogen, oxygen contaminated in the semiconductor film, since these

contaminations can prevent a crystal from growing. This is particularly important when a metal catalyst is present to promote crystallization of the semiconductor film.

Claims 1-4, 6-9, 11-14, 16-19, 21-24, 39-72 are rejected under 35 U.S.C. 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Zhang et al., U.S. Patent 5,614,733. Further, claims 1-4, 6-9, 11-14, 16-19, 21-24, 39-72 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhang et al., U.S. Patent 5,614,733 in view of Yamazaki, U.S. Patent 5,543,636. The cancellation of the above-noted claims renders these rejections moot. However, the rejection is traversed with respect to newly added claims 73-86 for the reasons advanced in detail below.

The Examiner notes that the limitation "with no grain boundary" does not structurally distinguish the claims over Zhang '733 because applicants have not proven that there is a grain boundary in the channel of '733. Moreover, the Examiner contends that, in column 4, lines 5-34 of '733, it is shown that no grain boundaries should exist in the channel region. The Examiner also relies on Yamazaki '636 to teach and suggest the appropriate levels of oxygen, nitrogen, and carbon in a device as disclosed by the '733 reference.

Applicants contend that the concentrations of the impurities in the semiconductor film is effective to form no grain boundary. If the concentrations of carbon, nitrogen, and oxygen were higher than the range indicated by the claimed invention, crystal growth of silicon would be prevented with no grain boundary. Accordingly, a monodomain region could not be formed. As a result, Zhang '733 cannot anticipate the claims of the instant application, since this references fails to teach or suggest the recited concentration of oxygen, nitrogen and carbon impurity.

?

Additional distinguishing features between Zhang '733 and the claimed invention are described in greater detail below and relate to the temperatures at which the thin film transistors are formed in each case. These distinguishing features illustrate further that Zhang '733 does not inherently disclose the thin film transistor of the present invention.

Specifically, in EXAMPLE 1, Zhang's silicon film is heated at a temperature of 200-450°C (e.g., 300°C) during the irradiation with a laser light (See, col. 5 lines 39-40 of Zhang '733). Then, the laminate is annealed at 500°C for 4 hours in a reducing ambient to crystallize the regions which were not irradiated with the laser light (col. 5 lines 46-49). In EXAMPLE 2, during the laser irradiation, the substrate is heated to 200-450°C, e.g., 400°C. Then, the laminate is annealed at 500°C for 4 hours in a reducing ambient to crystalize the non-irradiated portions of the amorphous silicon film (col. 7 lines 5-8). Further, in EXAMPLE 3, during the laser irradiation, the substrate is heated to 100-450°C, e.g., 300°C (col. 8 lines 51-52), and in EXAMPLE 4, during the laser irradiation, the substrate is heated to 100-450°C, e.g., 350°C (col. 10 lines 14-16). Accordingly, although Zhang '733 teaches heating the silicon film during the laser irradiation and subsequently annealing it, the temperature during the irradiation is different from that of the subsequent annealing.

On the other hand, for the claimed invention, the temperature at the laser irradiation step is the same as that at the subsequent annealing step. Support for this distinction is provided in the specification on page 8, line 29 to page 9, line 6. Specifically, there is an alternative method wherein, after the formation of an amorphous silicon film followed by the introduction of metal elements for promoting crystallization, laser irradiation is performed to form regions which can be regarded as single crystal regions. In this case, it is important that the sample is

heated to 450 to 750 °C, and 450 to 600 °C (750 °C if the substrate is resistant enough) if a glass substrate is used.

A heating process following the laser irradiation at 450 to 600 °C (750 °C if the substrate is resistant enough) is effective in reducing defects in the film. Heating process, laser irradiation, second heating process and the like are most effective if they are performed repeatedly in succession at the same temperature. As mentioned above, it is important and effective to prevent the temperature from being lowered under 450-750 °C in the thermal annealing, which is a same range used during laser irradiation. A silicon film having no grain boundary, that is, a monodomain region, cannot be successfully obtained unless these steps are performed. As a result, since Zhang is not concerned with this aspect of temperature, the claimed invention is distinct from the reference since the monodomain region of the present invention could not be formed in device disclosed by Zhang '733.

With respect to Yamazaki '636, this document discloses the recited concentrations of carbon, nitrogen, and oxygen. However, because '636 does not include using a metal element such as nickel as a catalyst for promoting crystallization of an amorphous silicon film, Yamazaki does not provide for the formation of no grain boundary. Although the Examiner asserts that the prior pending claims are obvious since Yamazaki '636 teaches and suggests the appropriate levels of oxygen, nitrogen, and carbon for a device as Zhang '733, the recited impurity concentration recited in the currently pending claims do not inherently provide no grain boundaries.

As provided above, a monodomain region could not be formed if the concentration of the recited impurties are above the recited range. It does not, however, follow that providing a silicon layer with impurities below these levels inherently provides no grain boundaries. The instant invention first finds a

relationship between the levels of carbon etc. and obtaining no grain boundary, particularly when a catalyst metal is used to promote crystallization.

In view of the foregoing, it is respectfully requested that the rejections of record be reconsidered and withdrawn by the Examiner, that claims 73-86 be allowed, and that the application be passed to issue. If a conference would be of benefit in expediting the prosecution of the instant application, the Examiner is hereby invited to telephone counsel to arrange such a conference.

Respectfully submitted,

Jeffrey L. Costellia
Reg. No. 35,483

Sixbey, Friedman, Leedom & Ferguson, P.C.
2010 Corporate Ridge, Suite 600
McLean, Virginia 22102
(703) 790-9110